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Aspects of Oral Brooding in the Cardinalfish *Cheilodipterus affinis* Poey (Apogonidae)

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INTRODUCTION

On February 1, 1968, rotenone collecting in the west bay of little San Salvador (Little Cat Island), Bahamas, resulted in the capture of two specimens of the longtooth cardinalfish, *Cheilodipterus affinis* Poey, that were remarkable in having a heavily pigmented, fleshy protuberance at the tip of the lower jaw (fig. 1). As far as we are aware, such structures have never been reported in any species of apogonid. Fleshy pads, however, do occur in the oromandibular cavities of certain mouthbrooding cichlids, and we have compared the histology of one of our specimens with the pharyngeal pad of an orally brooding cichlid.

Acknowledgments

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Dr. James W. Atz directed our attention to references on mouthbrooding fishes, provided histological preparations of the pharyngeal pads of *Geophagus jurupari* Heckel, and critically read the manuscript. We are indebted to Dr. M. L. Bauchot of the Paris Museum and Dr. Ernest A. Lachner of the U.S. National Museum, Smithsonian Institution for permission to examine specimens under their care. Dr. T. Fraser of the J.L.B. Smith Institute of Ichthyology, Rhodes University, Grahamstown, South Africa provided information on oral brooding in *Cheilodipterus affinis*.

SPECIMENS EXAMINED

From the localities listed below, 219 specimens of *Cheilodipterus affinis* Poey were studied. All lengths are given as standard lengths (s.l.).

Bahamas

Academy of Natural Sciences of Philadelphia No. 109578. TS-82. West Bay of Little San Salvador (Little Cat Island), 20 feet, February 1, 1968, J. C. Tyler. 2 ♂, 54.7–57.3 mm.

A.N.S.P. No. 97012. Green Cay (north of Rose Island, coral head about ¼ mile, north-northwest of Cay), 0–50 feet, May 14, 1959, C. C. G. Chaplin, J. E. Böhlke, et al. 30 ♂, 24.3–39.8 mm.; 26 ♀, 24.16–42.4 mm.

A.N.S.P. No. 107632. Great Bahama Bank off Hog Island, ½ mile north of Chaplin Home, 40 feet, April 17, 1965, C. C. G. Chaplin, J. E. Böhlke, et al. 5 ♂, 32.5–62.3 mm.; 4 ♀, 37.2–42.9 mm.

West Indies

Muséum National d'Histoire Naturelle No. A. 9555. Martinique, collected about 1884 by Monsieur Chaffajon. 1 ♀, 84.6 mm.

Venezuela

United States National Museum Accession No. 254316. Latitude 12° 07′ N., longitude 72° 33′ W., 40 fathoms, June 1, 1964, *Oregon* Station 4916. 144 specimens, 85 ♂, 46.6–82.1 mm.; 59 ♀, 46.6–71.7 mm.

U.S.N.M. Accession No. 247715. Latitude 11° 41′ N., longitude 69° 32′ W., 30 fathoms, October 5, 1963, *Oregon* Station 4422. 2 ♂, 68.4–87.5 mm.; 2 ♀, 84.9–87.5 mm.

U.S.N.M. Accession No. 254315. Latitude 10° 44′ N., longitude 66° 09′ W., 40 fathoms, October 17, 1963, *Oregon* Station 4466. 2 ♂, 79.1–86.6 mm.; 1 ♀, 78.6 mm.

HISTOLOGY

The distal portions of the lower jaw of one specimen of *Cheilodipterus*

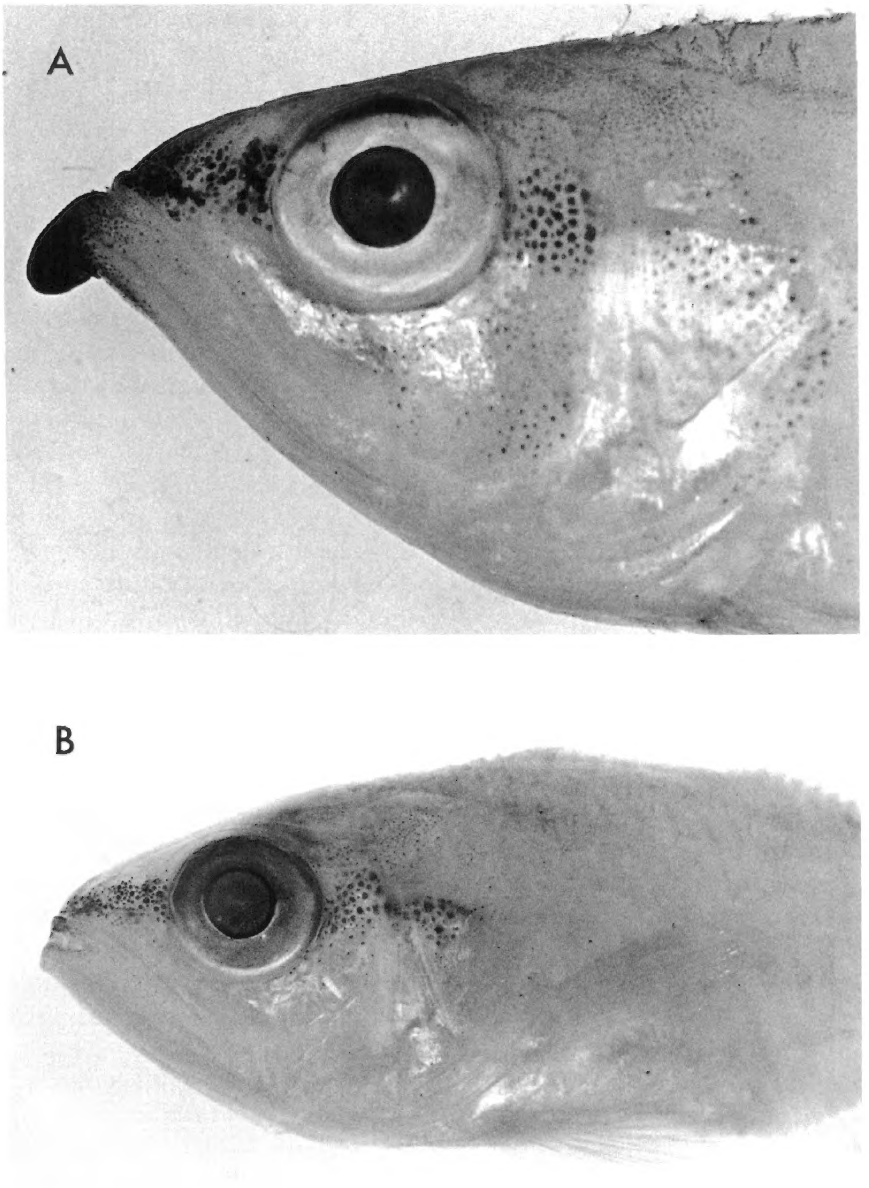

FIG. 1. *Cheilodipterus affinis*. A. Male showing enlarged chin flap, A.N.S.P. No. 109578, 54.7 mm. s.l. B. Male without the flap, A.N.S.P. No. 107632, 50.6 mm. s.l.

affinis (57.3 mm. s.l.) with the mandibular flap and a specimen (62.3 mm.) without the flap were removed, decalcified, embedded in paraffin,

sectioned at 7 microns, and stained in Masson's trichrome, except for a few slides which were stained in hematoxylin and eosin. Comparative material from the pharyngeal pads of *Geophagus jurupari* had been prepared in the same way.

The protuberant chin tab seems to be chiefly the result of an increase in the amount of loose, collagenous, dermal connective tissue. Neither the epidermal tissues nor the dense collagenous layer immediately underlying the epidermis appears to be developed to an unusual degree. Hypertrophy of the dermis is also present in the regions adjacent to the lower lip and the area immediately posterior to the mandibular symphysis, the lower oral valve, and in the prelingual region where the swollen tissues have produced a secondary fold parallel to the oral valve (fig. 2). The specimen with the flap also has conspicuous fucsinophilic cells in the epidermis, and these coarsely granular cells are particularly numerous in the secondary folds between the tongue and the oral valve. Similar cells are present but much less common in the other specimen.

As far as can be determined from the sections, the dentary bone and the lateral-line canals are identical in the two specimens, but the geniohyoideus muscle is smaller in cross section in the specimen with the flap.

A large, diffuse mass of cells—an intense tissue reaction to an unencapsulated parasitic worm—lies between the intermandibular muscle and the tendons of the genio-hyoideus of the specimen with the flap. Two encapsulated worms lodged in the intermandibular muscle elicited a far less intense and more confined tissue response. In the individual without the flap, there is no parasitic involvement in this area, and the loose stroma in this region is cell free.

Sections of the gonads of both specimens reveal that they are post-spawning males with sperm in the tubules but with relatively few cells undergoing active spermatogenesis. In this species the testes are divided into lobules, and in the specimen without the flap there is a considerable amount of melanin pigment in the interlobular walls. The specimen with the flap, however, has little or no melanin in the same areas.

In all the usual meristic and morphometric features, both specimens with the flap are indistinguishable from other individuals of the same species. They are neither extremely large nor exceptionally small, and the development of the flap cannot be ascribed to the effect of extreme size.

Although a few species of apogonids have been described as having a deeply pigmented area at the tip of the mandible, we have found no record of any exhibiting a mandibular flap, nor have we seen such a structure among the numerous species of apogonids that we have examined from both the Indo-Pacific and Western Atlantic. All cardinal-

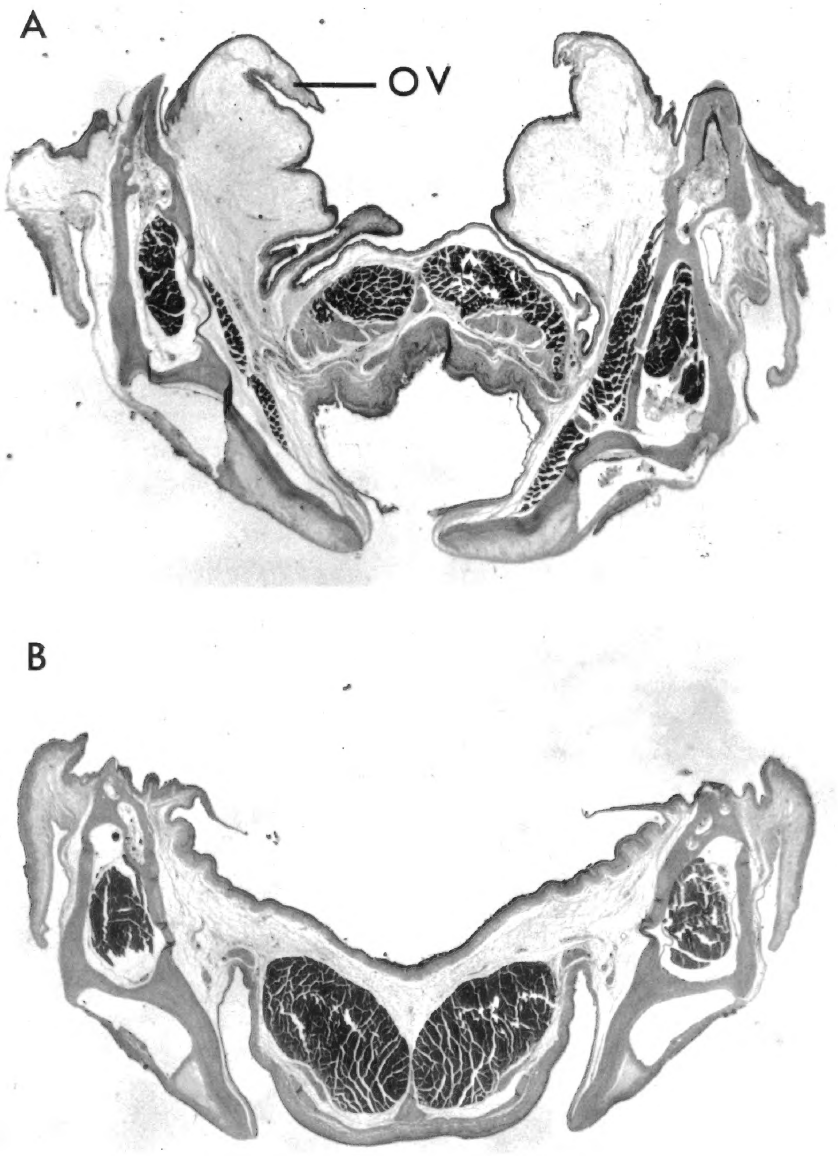

FIG. 2. Cross sections of lower jaws of *Cheilodipterus affinis*, posterior to mandibular symphysis. A. Specimen with protuberant flap. B. Specimen without flap. Note enlargement of the oral valve (OV) and the region ventral to it in the specimen with the flap.

fishes practice oral brooding as far as known (Breder and Rosen, 1966), and it is therefore of considerable interest that similar hypertrophied tissues are present on the anterior gill arches of some mouthbrooding cichlids. Pads on the first branchial arch have long been associated with oral brooding in cichlids (Pellegrin, 1903; Reinboth, 1956). We have compared the histology of the chin flap of *Cheilodipterus affinis* with that of the pharyngeal pads of *Geophagus jurupari,* both sexes of which brood the eggs and young (Reid and Atz, 1958). Histologically the structures are remarkably similar (fig. 3). In both, the enlargement seems to result from a large amount of loose, collagenous connective tissue in the dermis, and other tissues do not seem to be directly involved. Coarsely granular cells, similar to the fucsinophilic cells that are especially apparent in the epidermis of *Cheilodipterus,* are also present. They are not so numerous nor so brightly stained as in *Cheilodipterus,* however, nor are they confined to the epidermis, but also are present in the dermis and occasionally in blood vessels.

Oral Brooding in *Cheilodipterus affinis*

The similarity of the hypertrophied mandibular tissues of *Cheilodipterus* and the pharyngeal pads of a known mouthbrooder suggests that the chin flap has a function in oral brooding. Typically, the eggs of orally brooding apogonids are held together in a mass that projects out of the mouth and therefore would be in contact with the mandibular flap. It is perhaps also significant that the oral valve is involved in *C. affinis,* since Reid and Atz (*op. cit.*) have indicated that the oral valve plays a role, as yet unknown, in the mouthbrooding of *Geophagus jurupari.*

Cheilodipterus affinis is not an uncommon species, but it is not collected so frequently as some of the other apogonids because it dwells at depths greater than 40 feet (as deep as 145 fathoms according to Böhlke and Chaplin, 1868, p. 235) and because it prefers caves and deep, dark overhangs. Nevertheless, it is surprising that specimens with conspicuously developed mental flaps have not been reported before.

The first record of oral brooding in this species was that of Vaillant (1903) who did not mention the sex of his specimen. A re-examination of this fish at the Muséum National d'Histoire Naturelle revealed that it is a large female (84.6 mm.) with round eggs *ca.* 0.4 mm. in diameter in its mouth, and follicular ova of about the same size in the ovary. It does not have a developed chin flap. This species may thus be added to those few apogonids in which the female is known to carry eggs in the mouth (Breder and Rosen, 1966).

One of the two Bahamian specimens with chin flaps, the 54.7-mm.

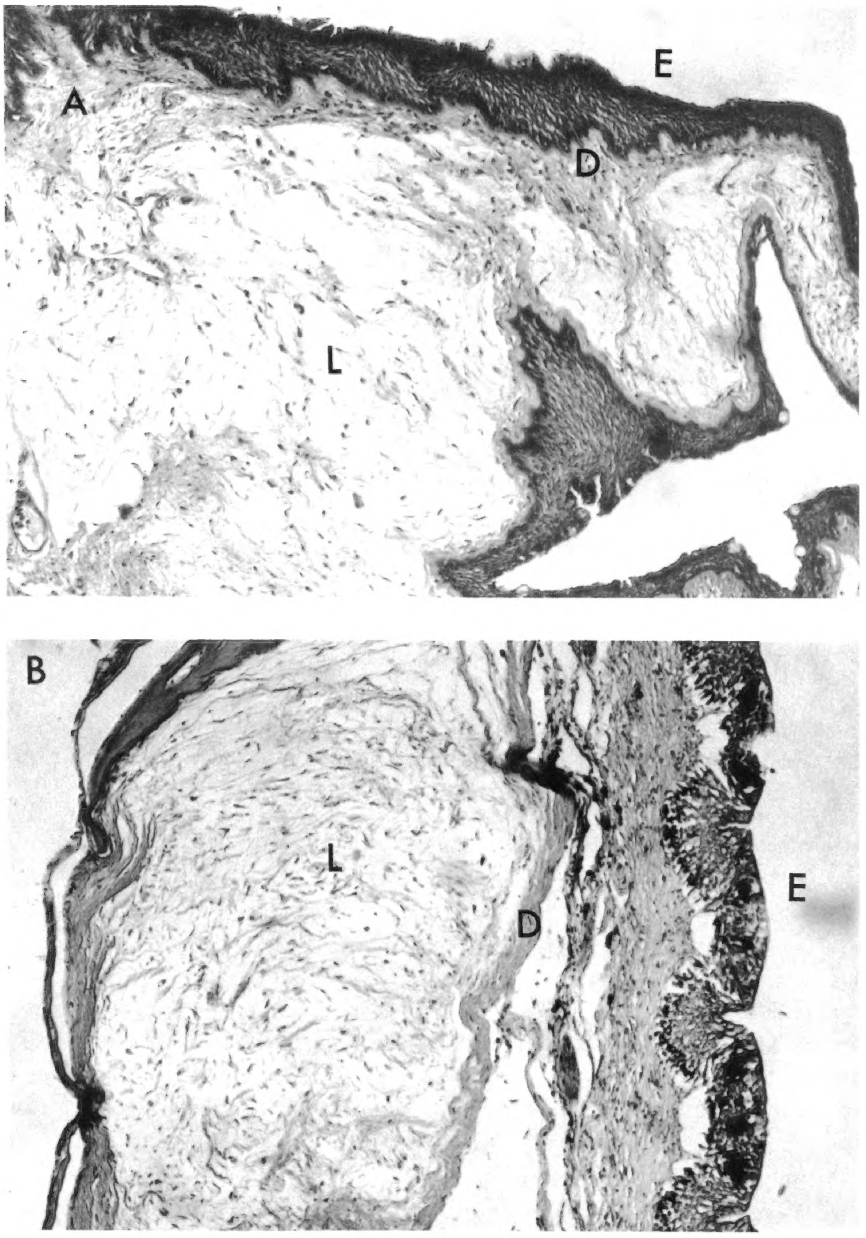

FIG. 3. A. Section of the oral valve of *Cheilodipterus affinis* with protuberant flap. B. Section through the pharyngeal pad of *Geophagus jurupari.*

Abbreviations: E, epidermis; D, dense connective tissue; L, loose, collagenous connective tissue.

specimen that was not sectioned, had eggs in its mouth. These were not in a compact mass and may represent the remnants of a mass that was mostly expelled when the specimen was collected or was placed in formalin.

Examination of numerous scuba and rotenone collections of *Cheilodipterus affinis* from the Bahamas and elsewhere in the Caribbean has failed

TABLE 1

CORRELATION BETWEEN DEGREE OF MANDIBULAR FLAP DEVELOPMENT AND EGGS IN THE MOUTH CAVITY IN *Cheilodipterus affinis*

(Numbers in parentheses are standard lengths in millimeters)

	Mandibular Flap Development			
	Absent	Small	Medium	Large
Males				
With eggs				
Venezuela	0	2 (72.4, 75.8)	3 (76.1–87.5)	1 (86.6)
Bahamas	0	0	0	1 (54.7)
Without eggs				
Venezuela	81 (46.6–82.1)	1 (74.0)	1 (71.4)	0
Bahamas	35 (32.2–62.3)	0	0	1 (57.3)
Females				
With eggs				
Martinique	1 (84.6)	0	0	0
Venezuela	0	0	0	2 (76.6, 84.9)
Without eggs				
Venezuela	60 (46.6–78.6)	0	0	0
Bahamas	30 (24.6–42.9)	0	0	0
Totals	207	3	4	5

to reveal other specimens with developed mandibular flaps. Series of specimens collected in trawls by the U.S. Fish and Wildlife Service vessel *Oregon* off Venezuela, however, include a few individuals with various degrees of flap development. The series that contained such specimens (listed under Venezuela above) were studied in detail, and the results are summarized in table 1. Twelve specimens (10 males and two females) out of 219 had chin flaps and eggs in the mouth. We can probably safely assume that the three males with flaps and no eggs had spit out their eggs when they were collected. Two females had eggs and chin flaps; the third female with eggs in her mouth (the specimen reported by Vaillant) exhibited no chin flap.

Most of the eggs were between 0.35 and 0.4 mm. in diameter. An

estimate was made of the number present in the mouth of the 84.9-mm. female from *Oregon* Station 4422, whose mouth was relatively full of eggs. Measured compactly, there were 4.1 milliliters of eggs of which a 0.2-milliliter aliquot (4.88 per cent) contained 977 eggs. There were also several hundred eggs on the bottom of the jar that housed this specimen and one apparently non-brooding specimen. The total number of eggs being incubated by the specimen was about 21,000. All the eggs seemed to be at approximately the same stage of development, but they were of two distinct types. About two-thirds of the eggs were substantially darker and much less firmly attached to one another in clumps than were the others, which were not only paler but were more firmly imbedded in a thin matrix. These were found only at the rear of the branchial cavity—to the exclusion of the darker eggs. This circumstance may indicate that the incubating eggs had come from two different females, one that produced eggs with more carotenoid pigments but a less substantial external matrix than the other. Brooders with eggs from more than one fish are known in *Apogon semilineatus* from off Japan (Ebina, 1932) and strongly suspected in *Cheilodipterus lineatus* from the Red Sea (Fishelson, 1970).

One of the Venezuelan specimens, a 78.1-mm. male from *Oregon* station 4916, had eggs that were hatching in its mouth. The young were 0.7 mm. in diameter coiled, and about 1.0 mm. long when uncoiled. Most of them were in the process of escaping from the egg membranes, which were still attached to one another.

Meristic and morphometric comparison of the Bahamian reef specimens collected with rotenone with Venezuelan specimens caught in a trawl revealed no consistent differences although the trawl-caught specimens tended to be larger (46.6–86.6 mm. as compared with 24.6–62.3 mm.). This may be the result of selectivity of the collecting method, but we consider it more likely that there is a real difference, that is, members of the deep-water populations off Venezuela tend to reach a larger size. Whether this indicates an offshore migration of larger individuals or is merely a reflection of growth-favoring conditions in deeper water we cannot say, but the absence of meristic differences suggests that no genetic distinction exists between the populations. Although the flaps are developed only in relatively large specimens, the Bahamian specimens with flaps are not the largest individuals from the Bahamas, and while the largest Venezuelan specimens do have flaps, some of the Venezuelan specimens without flaps are larger than some of those with flaps from the same trawl haul. A number of females without flaps have large, ripe or nearly ripe ovarian eggs. Thus, the development of the flap does not

seem to be strictly correlated with size and, in females at least, is not correlated with the presence of mature sex products.

The two Bahamian specimens with developed flaps were taken in a somewhat unusual situation, namely a low coral mound in a shallow bay where the water was only 20 feet deep. As mentioned before, *Cheilodipterus affinis* is more commonly taken on the deeper reefs of the vertical wall of the Bahamian banks at depths of 60–150 feet. It is conceivable that males or females with eggs (and chin flaps) hide so deeply in such reefs that they are seldom taken, even by divers using rotenone. On open bottom, however, the brooders would be more vulnerable to capture and this could account for the larger number of adults with chin flaps in trawl collections.

SUMMARY

Two specimens of *Cheilodipterus affinis* Poey from the Bahamas have darkly pigmented, fleshy, protuberant chin flaps. One of these was sectioned and compared histologically with the tip of the mandible from a specimen without the flap. The flap seems to be the result of an increased amount of loose, collagenous connective tissue and histologically bears a strong resemblance to the pharyngeal pads of the mouthbrooding cichlid, *Geophagus jurupari*. Ten additional specimens with chin flaps have been found in trawl collections made off the coast of Venezuela. This cardinalfish is an oral brooder: eggs have been found in the mouths of seven males and three females. Two of the females and all of the males with eggs in their mouths had chin flaps, but one female without a flap was carrying eggs.

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